Developing Mathematical Thinking Through Questioning Strategies

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Common Core State Standards for Mathematics

Two Types of Standards:

- **Mathematical Practice** (recurring throughout the grades)
- **Mathematical Content** (different at each grade level)

Standards for Mathematical Practice

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Standards for Mathematical Practice

"The Standards for Mathematical Practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. These practices rest on important "processes and proficiencies" with longstanding importance in mathematics education."

(CCSS, 2010)

The Nature of Tasks Used in the Classroom …

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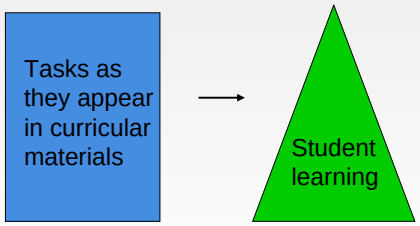
Will Impact Student Learning!



But, WHAT TEACHERS DO with the tasks matters too!

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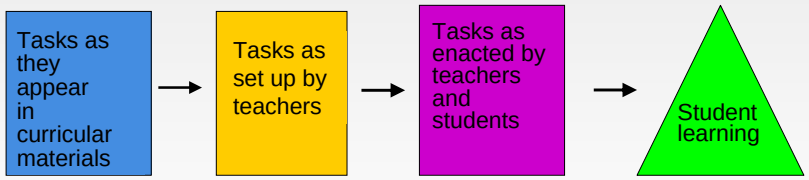
The Mathematical Tasks Framework



Stein, Grover & Henningsen (1996)
Smith & Stein (1998)
Stein, Smith, Henningsen & Silver (2000)

Using Questioning to Elicit Thinking

- Goals –
- A) To become aware of the power of carefully chosen questions in eliciting and developing children's mathematical thinking and reasoning
- B) To consider the importance of holding back from telling students something something they could work out for themselves

Responding to a Computation

- **You complete the responses.**
- **Please, Miss, is this correct?**

81 **No.**
- 54
33

Write at least four other possible responses on the page.

Analyze Your Questions

- Consider each response on the handout in turn, and consider the questions below:
- Does this response help to elicit and develop children's thinking? In what ways?
- Am I telling students something they could figure out for themselves?

Encouraging Thinking

- Look at the comments on handout 2.2. Select one comment that you believe would elicit student thinking and one that you think would not. Be prepared to give the reasons why or why not.

Generic Questions

- Questions such as
- How did you work that out?
- Could you solve that another way?
- Could you generalize your result?

What other generic questions could be added to the list? How does this give you formative information about what the student knows and doesn't know?

Open and Closed Questions

- Consider the following two questions:
- What is the mean 5, 11, 7, and 1?
- I have four numbers with a mean of 6. What might those numbers be?
- What kind of responses might each of the questions yield? What might students learn from answer each of the questions? What might the teacher learn from how students answer these questions?

Additional Open Ended Questions

- You add two fractions and the sum is $\frac{9}{10}$. What could the fractions be?
- The answer is 42. What is the question?

Questions and Prompts for Mathematical Thinking

- Watson and Mason (1998) developed "stems" of questions "to provoke children into becoming aware of mathematical thinking processes"
- Using the concept on your file card, and the question stems on your handout, create at least three questions that you would believe would be powerful in eliciting and developing mathematical thinking for students.

Ideas for Classroom Application

* Looking ahead at the topic to be studied, find one closed question in the textbook and "open it up".
* Choose an upcoming mathematical topic and develop five questions that use the Watson-and-Mason stems.
* Try to use one or more of the generic questions on a regular basis.

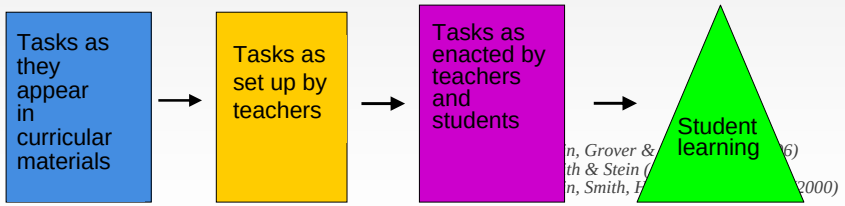
"Questioning our Patterns of Questioning"

- Read the article.
- Highlight or underscore ideas that you would like to remember.
- Using the "Final Word" Strategy, share out with your group.

Analyzing Scripts

- Read the script given to your group. Decide what questions could have been used to focus the discussion, instead of funneling.
- Be prepared to share with the whole group.

What are the implications of these activities, considering that we will have the same textbooks for several more years?



Citations

- **CaCCSS-M Resources Home, (2011)**
- http://caccssm.cmpso.org/k-8-modeling-task-force
- Small, M. (2009) *Good Questions: Great Ways to Differentiate Mathematics Instruction,* Teachers College Press, Columbia.
- Clarke, B. and Clarke, D. Using Questioning to Elicit and Develop Children's Mathematical Thinking. NCTM.
- Stein, Mary Kay, and Margaret Schwan Smith. "Mathematical Tasks as a Framework for Reflection: From Research to Practice." *Mathematics Teaching in the Middle School* 3 (January 1998): 268–75.